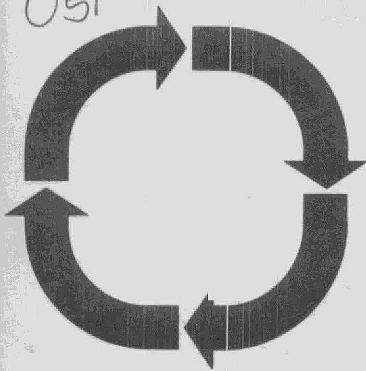


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Resource Recovery

ONTARIO CENTRE FOR RESOURCE RECOVERY

EXPERIMENTAL PLANT



Ontario

Ministry
of the
Environment



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ONTARIO CENTRE
FOR
RESOURCE RECOVERY

EXPERIMENTAL PLANT

CANADIAN INSTITUTE OF ENERGY
SYMPOSIUM ON SOLID WASTE
MAY 4, 1977

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ENVIRONMENT ONTARIO

ONTARIO CENTRE FOR RESOURCE RECOVERY
EXPERIMENTAL PLANT

BACKGROUND

In October, 1974, the Province of Ontario announced a comprehensive waste management programme with two major goals.

1. To reduce the quantity of waste produced;
2. To recover to the greatest degree practicable the resource values in solid waste.

The report on this program emphasised the need to integrate and coordinate the various approaches available to achieve these goals; the need to pursue all of the approaches in parallel; and particularly, the need to retain the utmost flexibility in a new and rapidly developing field.

These general approaches are shown on figure 1:-

1. A reduction in the quantity of material produced which is likely to result in waste. Examples of possible means include the elimination of unnecessary packaging; the extension of product lifetime; greater use of refillable containers. Significant success will depend, ultimately, on a change in attitude of both producers and consumers, to emphasise material and energy conservation.
2. Separation of some elements of waste at the source; at the industrial, commercial, institutional and household level.

This is already being done by private industry, where it is practicable and economic. However opportunities for increasing the quantity of material already recycled exist, and should be exploited.

FIGURE 1

GENERAL SOLUTION APPROACHES

1. REDUCTION IN WASTE PRODUCED
2. SEPARATION AT SOURCE
3. PLANNED WASTE MANAGEMENT SYSTEMS
4. WASTE SEPARATION PLANTS
5. MATERIAL PROCESSING PLANTS
6. INCREASED USE OF RECLAIMED MATERIAL

3. Planned, coordinated waste management systems, from collection to final re-use or disposal. No single element of the system can be properly assessed in isolation. The selection of processing technology, for example, must be made by comparing total system costs, not merely processing plant costs.
4. Waste separation plants;
and
5. Material processing plants.

These may be combined in a single plant, which may or may not include waste separation processes. In some cases the material processing may be carried out at an existing industrial facility.

6. Encouragement for the reuse of recovered material, and the development of new uses for this material.

With regard to the last three items, we recognised, at an early stage that the information necessary for decision making, either by municipalities or the Province, was totally inadequate, and that this situation was unlikely to improve significantly.

No facility was then available, or even proposed, capable of generating the data we believed essential for the rational planning of a resource recovery program; for the design of a resource recovery plant; or for the development of the markets without which neither an overall program nor an individual plant could be viable.

It was for these reasons that the concept of an Ontario Centre for Resource Recovery was developed, the cornerstone of which would be a unique combination of full-scale, working plant and sophisticated research facility.

OBJECTIVES

The objectives of this facility, as set out in the original terms of reference, were:-

1. To investigate and compare the suitability of alternative procedures, processes and equipment for the separation and reclamation of components of municipal wastes;

2. To determine the feasibility of separation and reclamation plants as an alternative to present methods of disposal;
3. To examine the feasibility of staged or modular introduction of such plants;
4. To investigate the additional processing required for the marketing of reclaimed materials;
5. To investigate alternative outlets for such materials, and the methods and costs of handling;
6. To develop criteria by which the capital and operating costs of various types of plant of various sizes can be reliably estimated;
7. To develop criteria by which the environmental effects, including the consumption of energy, of reclamation can be gauged so that a reliable and complete comparison can be made between alternative processes;
8. To provide facilities to other agencies and to industries for the installation and testing in practice of equipment, instrumentation and processes related to their particular fields.

These objectives are summarised on figure 2:-

The terms of reference also emphasised that the basic processes selected for initial installation should:

1. Be of adequate capacity so that the results obtained could be utilised in the design of larger plants, of at least 1000 tons per day;
2. Have the potential for application in stages;
3. Provide maximum flexibility to exploit new technology and markets as they are developed.

FIGURE 2
SUMMARY OF OBJECTIVES

1. TO DEVELOP AND EVALUATE PROCESSES AND EQUIPMENT FOR RESOURCE RECOVERY;
2. TO DEVELOP CRITERIA FOR DESIGN AND FOR ESTIMATING CAPITAL AND OPERATING COSTS;
AND
3. TO PROVIDE A REGULAR SUPPLY OF RECOVERED RESOURCES FOR PRODUCT UTILISATION AND MARKET DEVELOPMENT

AND IN ADDITION

4. TO PROVIDE FACILITIES FOR THE TRAINING OF OPERATORS OF OTHER PLANTS; AND
5. BY MAKING PROVISION FOR PUBLIC VIEWING THROUGHOUT THE FACILITY, TO PROMOTE INTEREST AND DISSEMINATE INFORMATION ON WASTE REDUCTION AND RESOURCE RECOVERY

GENERAL TECHNOLOGY

To put this in context, figure 3 summarises the available technological approaches from which a selection had to be made.

In the opinion of our consultants, Kilborn Engineering Limited, the density separation approach involving shredding and air classification of the bulk wastes, best met the terms of reference, particularly the requirements for maximum flexibility and capability for staged development.

The joint technical committee set up to supervise this project, comprising myself, Ian McKerracher and Eric Sanderson, at that time Chief of the Solid Waste Division of Environment Canada, were in complete agreement with the consultant.

It is perhaps worth noting that, with the exception of on-grate incineration and wet separation, it is possible that the other approaches could, in fact, be used as auxiliary or 'back-end' modules in conjunction with a basic density separation plant.

Subsequently, in late 1974, Kilborn Engineering Limited were commissioned by the Ministry to proceed with the design and construction management of the plant. The first stage, a direct transfer facility, is now in operation, and commissioning of the processing facilities will commence this summer.

GENERAL DESCRIPTION OF PLANT

The Experimental Plant for Resource Recovery is located on an 18-acre site in the Borough of North York, Metropolitan Toronto. The plant is designed to receive general municipal solid waste as collected from residential and commercial sources in the Metropolitan Toronto area; hazardous materials, such as pathological or chemical wastes, and non-processable materials, such as demolition wastes, will not be received at the facility.

The plant comprises the following features:-

- Scalehouse;
- Receiving/transfer/paper recovery building;
- Shredding and air separation/classification building;
- Commodity and energy recovery building, and
- Composting building.

FIGURE 3

AVAILABLE TECHNOLOGY

| | | | | |
|-------------------------|---|-----------|---|----------|
| ON-GRATE INCINERATION |) | PRIMARYLY |) | COMBINES |
| SEMI-SUSPENSION BURNING |) | DISPOSAL |) | FRONT |
| |) | WITH |) | AND |
| PYROLYSIS |) | ENERGY |) | BACK |
| |) | RECOVERY |) | END |
| WET SEPARATION |) | |) | PLANTS |
| SIZE SEPARATION |) | PRIMARYLY |) | FRONT |
| |) | MATERIAL |) | END |
| DENSITY SEPARATION |) | RECOVERY |) | PLANTS |

All processing, with the exception of composting, is done on a dry basis and equipment is designed for an average capacity of 40 tons per hour with a peak capacity of 60 tons per hour; the plant will also be able to receive an additional 600 tons daily, in a single shift, and transfer out this tonnage without processing in 75 cubic yard compaction trailers for hauling to landfill sites. The direct transfer facilities not only provide an immediate service to the area, but also increase the overall versatility of the plant.

Additional features of the plant are an extensive instrumentation system; closed circuit television monitoring; use of a digital computer for handling process data, production information, power consumption in key areas, as well as all truck scale information; an extensive dust control system; and provision for public viewing throughout the facility.

Operation and direct management of the facility is conducted by Browning-Ferris Industries of Toronto Ltd., Resource Recovery Division, under terms of a five-year agreement negotiated with the Ministry of the Environment.

GARBAGE - QUANTITY AND QUALITY

Municipal refuse is primarily generated from the following sources: residential, at a rate of 1.7 pounds/capita/day plus an additional 0.5 pounds of trash/capita/day; commercial operation at a rate equivalent to 0.6 pounds/capita/day; and industrial solid waste production at a rate of 1.6 pounds/capita/day. Although these quantities are subject to both daily and seasonal variations, solid waste is generally considered to be produced at a rate equivalent to 4.4 pounds per person per day; this figure excluding wastes such as demolition and building rubble, sewage sludges, and parks wastes. Although firm statistics are not available, approximately 6.0 million tons of refuse are produced annually in the Province of Ontario.

While refuse is obviously a heterogeneous mass, a typical breakdown of materials present in solid waste is shown below:

COMPOSITION OF SOLID WASTE (percentage on a dry weight basis)

| | |
|-------------|----|
| Paper | 37 |
| Glass | 7 |

| | |
|---------------------------------|----|
| Metals | 7 |
| Food wastes | 19 |
| Yard wastes | 18 |
| Plastics | 3 |
| Rubber, leather, wood, cloth .. | 7 |
| Miscellaneous | 2 |

Again, this overall composition is also subject to both daily and seasonal variations.

Although solid waste contains these apparently recoverable materials in significant quantities, some of the constraints to resource recovery are the heterogeneity of the material itself, and the fact that some of it is of a putrescible nature containing a high moisture content. Additional problems are presented through produce contamination, e.g. bimetallic cans, and plastic/paper laminations. The low bulk density of municipal refuse, about 10 pounds per cubic foot also means that large volumes must be processed to handle the tonnages produced by a municipality.

RECEIVING/TRANSFER

Vehicles arriving at the plant are first weighed at the scalehouse which has both incoming and outgoing 75 ton capacity electronic platform scales. All pertinent data including arrival and departure times, vehicle identification, gross and net weights, type of waste or product, and source or destination are stored in a digital computer and the information is used to automatically print out weigh tickets on the departure of the vehicle at the outgoing scale.

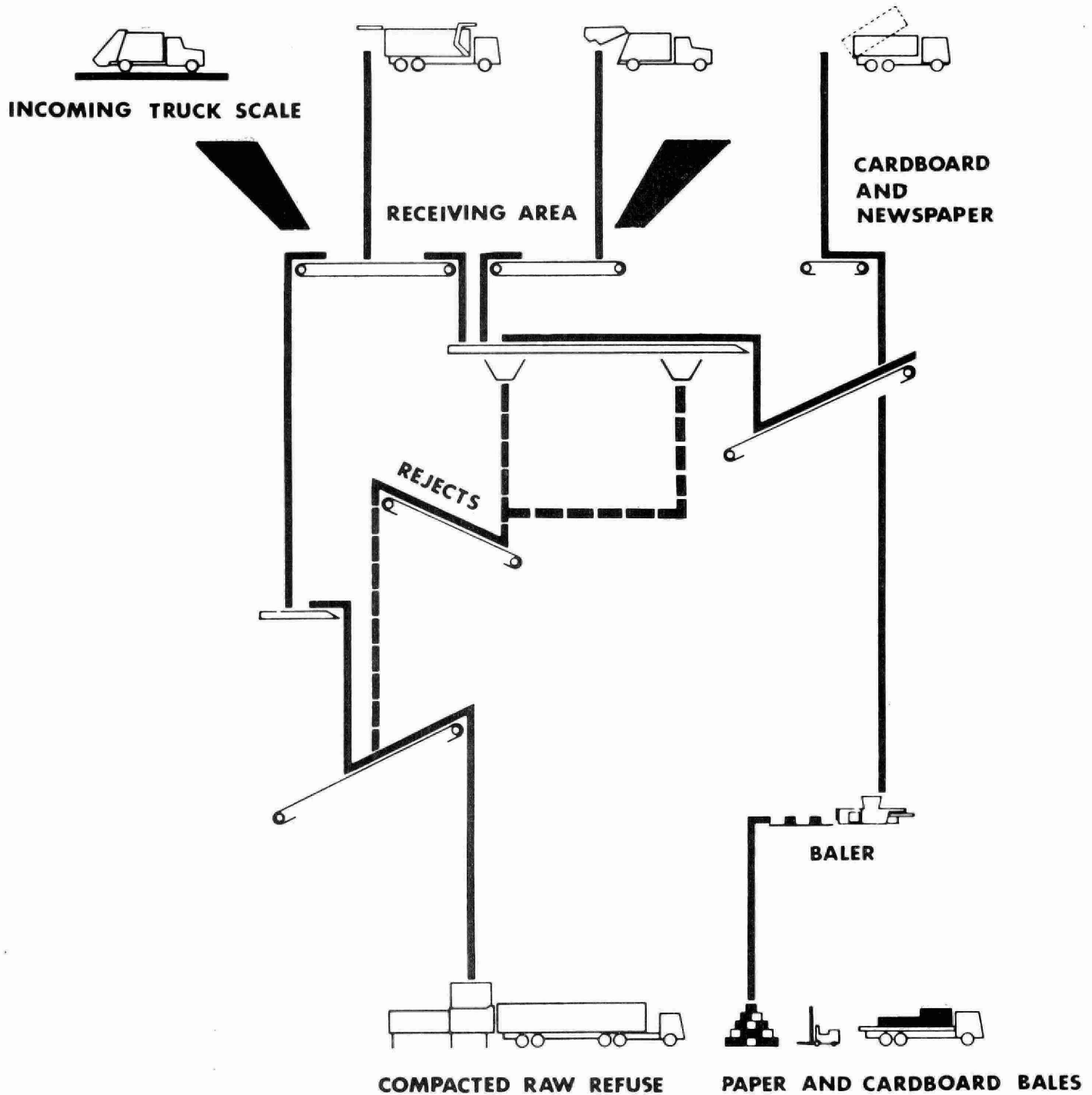
On entering the 12,000 square foot receiving area, refuse is discharged onto one of two 12-foot wide apron conveyors, located eight feet below the receiving floor. One conveyor is solely for feeding the resource recovery plant, and the other reversible conveyor may direct refuse either to resource recovery or to direct transfer. The receiving building is totally enclosed, ventilated by exhausting 60,000 cfm air, and supplied with in-floor heating.

Figure 4 is a materials flow schematic for the receiving and transfer areas of the plant.

FIGURE 4

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RECEIVING / TRANSFER SCHEMATIC



Solid waste deposited on the transfer side of the receiving floor, either directly onto the receiving apron conveyor or onto the adjacent floor, proceeds from the 12-foot wide apron conveyor along a 6-foot wide vibrating conveyor and similar apron conveyor into a double hopper that selectively supplies this bulk waste to a pair of 11 cubic yard hydraulic compaction units for loading into enclosed 75 cubic yard compaction trailers capable of hauling minimum 20 ton payloads to landfill. The double unit compactor design allows the transfer of up to 60 tons per hour for each compactor.

For resource recovery, solid waste on the receiving apron conveyor is fed onto a 6-foot wide vibrating conveyor levelling out the refuse stream and providing maximum visual exposure and accessibility. Visual inspection of the refuse stream allows any hazardous or non-processable materials to be removed. The technical and economic feasibility of direct paper recovery by manual salvage at this point may also be evaluated. After inspection, solid waste then proceeds to the shredding and air separation building.

Loads with a high corrugated paper content may be discharged alongside a 6-foot wide floor flush conveyor located along one side of the main receiving building; this conveyor feeds directly into a 10 ton per hour double piston baler located in the adjacent paper recovery section.

SHREDDING/AIR SEPARATION

In Figure 5, a process flow schematic for the shredding and air separation/classification phases of the resource recovery facility is shown.

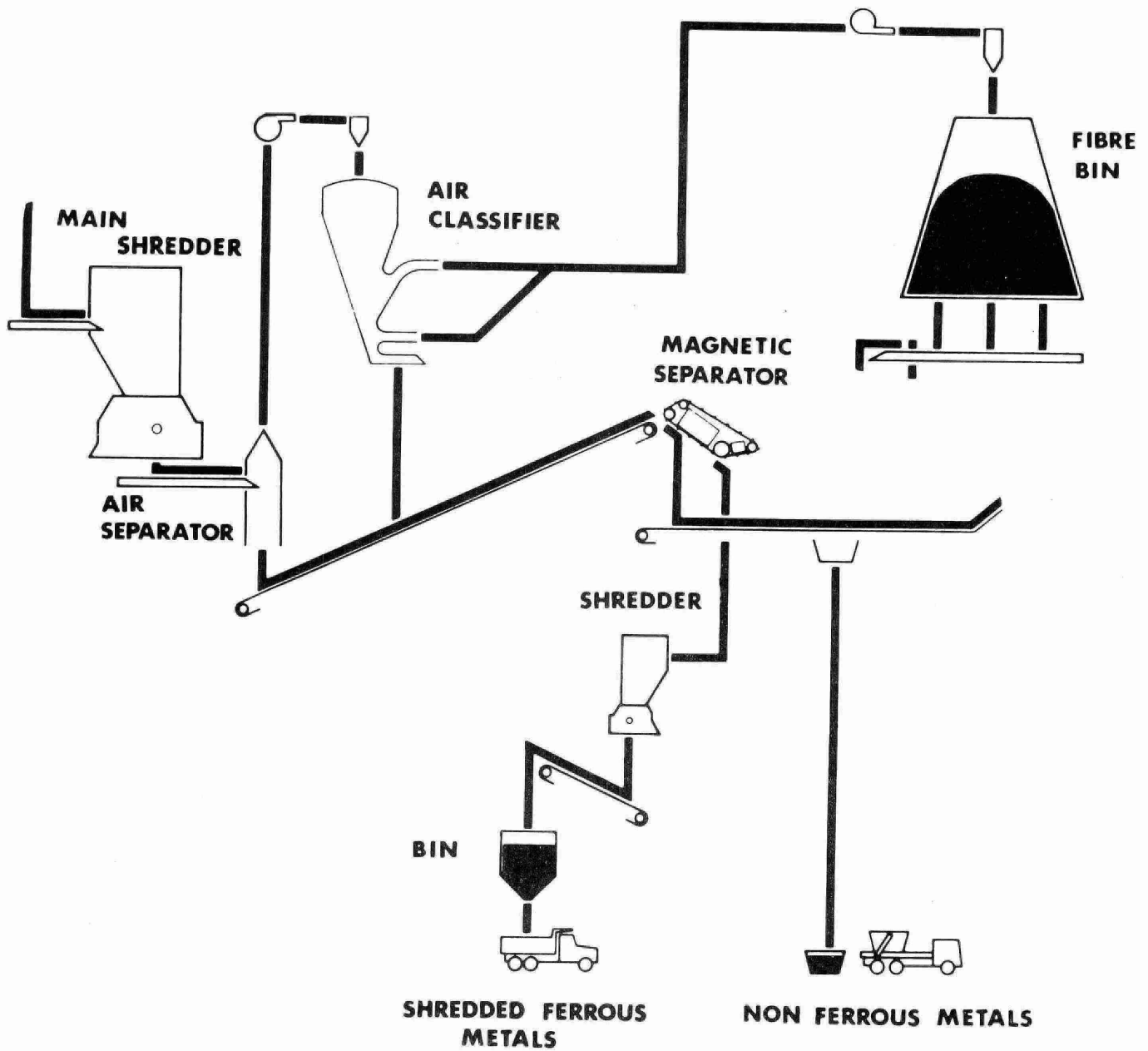
The average 40 ton per hour stream of whole solid waste leaves the receiving area on an elevating 6-foot wide belt conveyor carrying the material over a belt scale and into the adjacent shredding area, housing a horizontal shaft hammer mill type shredder driven by a 1000 hp motor.

Even though the refust has undergone visual inspection, the potential for fires and explosions within the shredder is significant. Protection against these inherent hazards is provided for by physically isolating the shredding area from the remainder of the plant, visual inspection of the refuse mentioned earlier, providing blow out panels on the shredder feed hood and similar blow out panels on the

FIGURE 5

- 10 -

COMMODITY RECOVERY SCHEMATIC NO. 1



shredder building itself, and by providing an extensive sprinkler system within the shredder building and on feed and discharge conveyors.

Although explosion suppression devices designed to counter deflagrations are available, such systems have not been highly successful in suppressing explosions in shredders handling municipal solid waste.

The primary shredder in this facility is designed to reduce all materials, including appliances and tires, to a minus six inch particle size, at a peak shredding rate of 60 tons per hour.

Shredder refuse is then subjected to crude separation in a high velocity vacuum air separator; this first separation produces a "light" stream, primarily paper, and a "heavies" stream containing material not carried off in the 50 fps air stream.

The "light fraction" rises through a 75 hp fan and enters a cyclone discharging into the density classifier. The high velocity air is removed and the material drops through the classifier where stratification under low velocity air currents results in additional "heavies" dropping out to join the original "heavies" stream. The refined light fraction is then pneumatically conveyed to a 15,000 cubic foot live bottom storage bin. This light fraction, approximately 40 per cent of the original refuse processed, is composed of shredded mixed paper and film plastic with a minor amount of organic material present. In loose form, this material has a bulk density in the order of 5 lb/cu ft.

COMMODITY RECOVERY

The heavy fraction, now representing approximately 60 percent of the raw refuse, is conveyed to the commodity recovery building where the initial recovery operation is ferrous removal by means of a three-stage electromagnet. All ferrous materials are removed and, depending upon the degree of processing required for marketing, may be further shredded to less than three inches in size in a 150 hp ring hammer mill. This shredded ferrous fraction is then air cleaned and conveyed to a 2500 cubic foot storage bin. An additional 6 percent of the raw refuse has now been recovered in this ferrous product, having a bulk density of 25-30 lb/cu ft.

The largest single class of material remaining is glass, now shattered particles, mostly minus $\frac{1}{4}$ inch in size. This fraction is recovered in a 20 foot long, 6 foot diameter trommel screen with uniform $\frac{3}{4}$ inch openings the entire length of the screen. As the glass rich fine fraction also includes contaminants such as ceramics, stones, and fine organic materials, this fine stream is further processed through a second density classifier to remove the organic materials and the resulting mixed glass is then stored in another 2500 cubic foot storage bin. The organic material removed in the classifier is pneumatically conveyed to a second 15,000 cubic foot storage bin.

The process flow schematics are shown for ferrous recovery in Figure 5 and for glass and organic recovery in Figure 6.

The oversized fraction from the trommel screen consisting of non-ferrous, ferrous, and organic material not previously separated, with a size range of $\frac{3}{4}$ inch to 6 inches, is conveyed to a 400 hp secondary hammer mill where all material is reduced to a minus 2 inch particle size. Upon discharge from the mill, the material enters an air separator where the lighter organic fraction is removed and pneumatically conveyed to the second 15,000 cubic foot live bottom storage bin. The heavy materials, such as non-ferrous metals and heavy organics which might have been carried through the separation processes to this point, are reject materials which are conveyed by bucket elevator to a 2500 cubic foot rejects storage bin.

STORAGE AND LOADOUT FACILITIES

The two 15,000 cubic foot storage bins hold approximately 100 tons of light fraction and organic material each. These bins have identical live bottom discharge systems and either product may be directed to a number of areas:

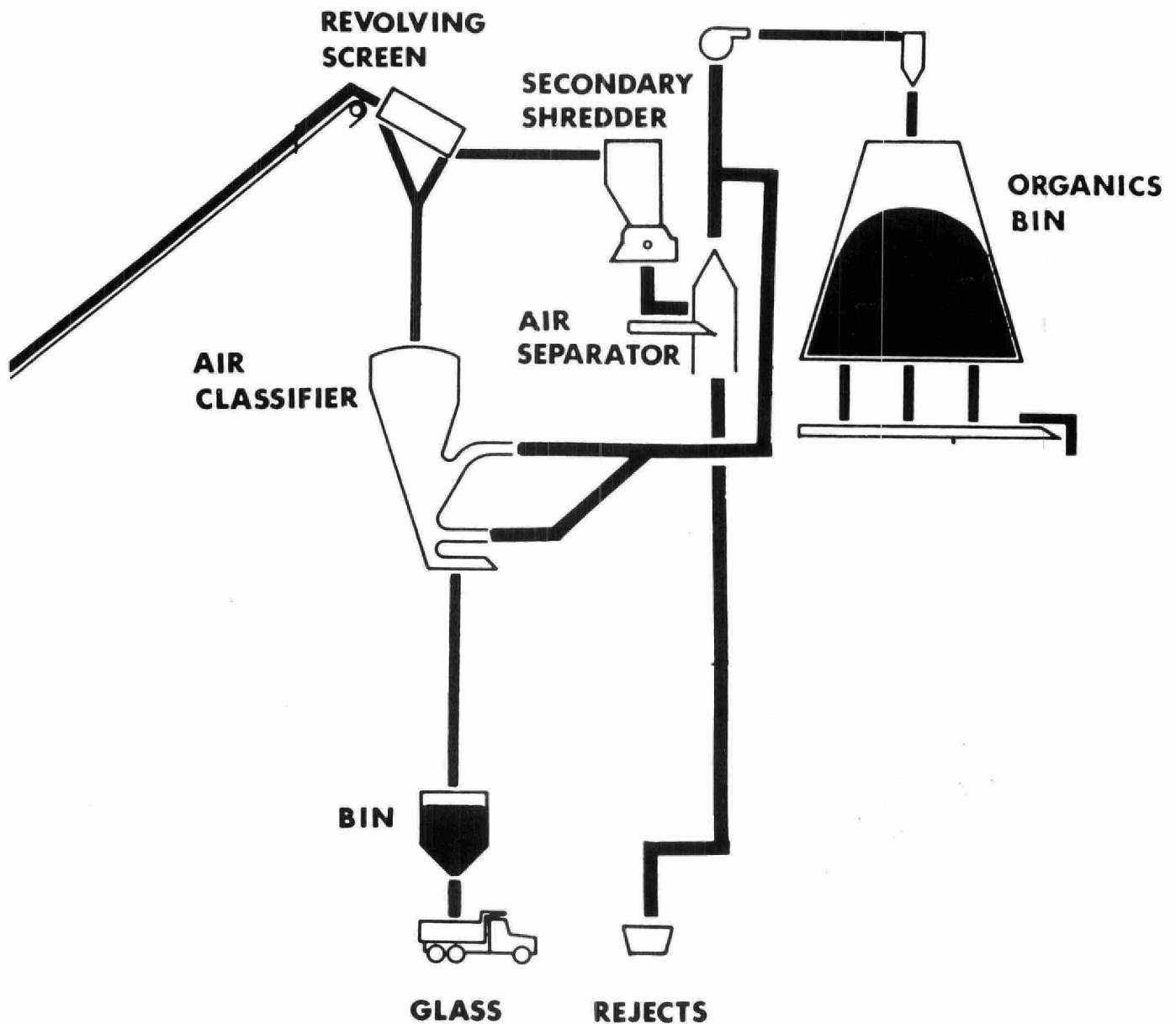
- fuel for the energy conversion unit,
- as a feed stock for the composting unit, and
- for bulk loadout via 11 cubic yard compactor into 75 cubic yard compactor trailers.

The light fraction bin unloading system has an additional discharge point for baling in a 15 ton per hour baler for shipment to potential users of shredded mixed paper.

FIGURE 6

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COMMODITY RECOVERY SCHEMATIC NO. 2



The three smaller 2500 cubic foot storage bins contain shredded ferrous material, mixed glass, and non-ferrous rejects, respectively. These bins are equipped with vibrating conveyors for direct discharge into vehicles or containers.

ENERGY CONVERSION UNIT

Solid waste represents a significant source of energy with the light fraction containing approximately 6,000 BTU's per pound on an as-fired basis. In order to evaluate this energy source and to assess small scale energy recovery systems, a solid waste fired, controlled air incinerator with heat recovery has been installed at the plant. This 18 ton per day unit features automatic loading, hot water recovery system, and automatic ash removal with the ash being conveyed to a sludge storage tank in the composting building. Energy recovery from the system is used for in-plant heating and to provide a heat source for the under floor heating in the receiving area. Utilization of the light and organic fractions in this unit will afford an opportunity to study, under controlled conditions, both the efficiency and pollution control aspects of such systems.

A process flow schematic for the loadout and energy recovery systems is shown in Figure 7.

COMPOST FACILITY

Since organic material constitutes a significant portion of municipal solid waste, and as this material has a natural ability to compost, the Experimental Plant for Resource Recovery includes a 50 ton per day compost digestion system.

A process schematic for this operation is shown in Figure 8.

Feedstock for the composting plant is pneumatically conveyed from the large organic storage bin to the compost preparation building where the solid feed material is mixed with sewage sludge in a pug mill to achieve the proper moisture content for composting. From the pug mill, the compost is fed to the 58-foot diameter digester equipped with thirteen bridge mounted augers to provide mixing of the 8-foot deep mass of composting material.

To ensure aerobic conditions during its nominal 5-day digestion period, a 4500 cfm blower provides air to the process through an air distribution system at

FIGURE 7

- 17 -

LOADOUT AND ENERGY RECOVERY SCHEMATIC

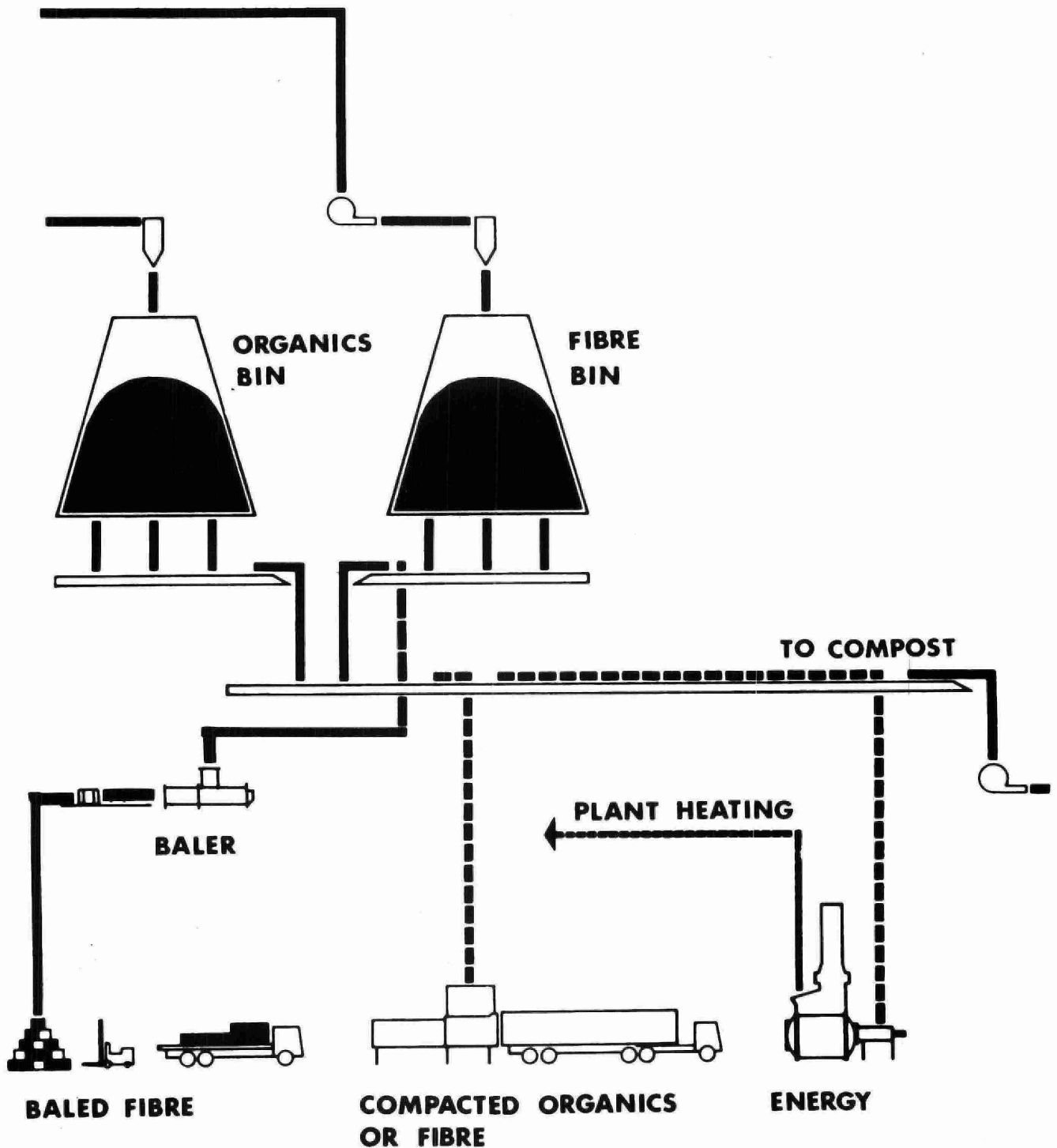
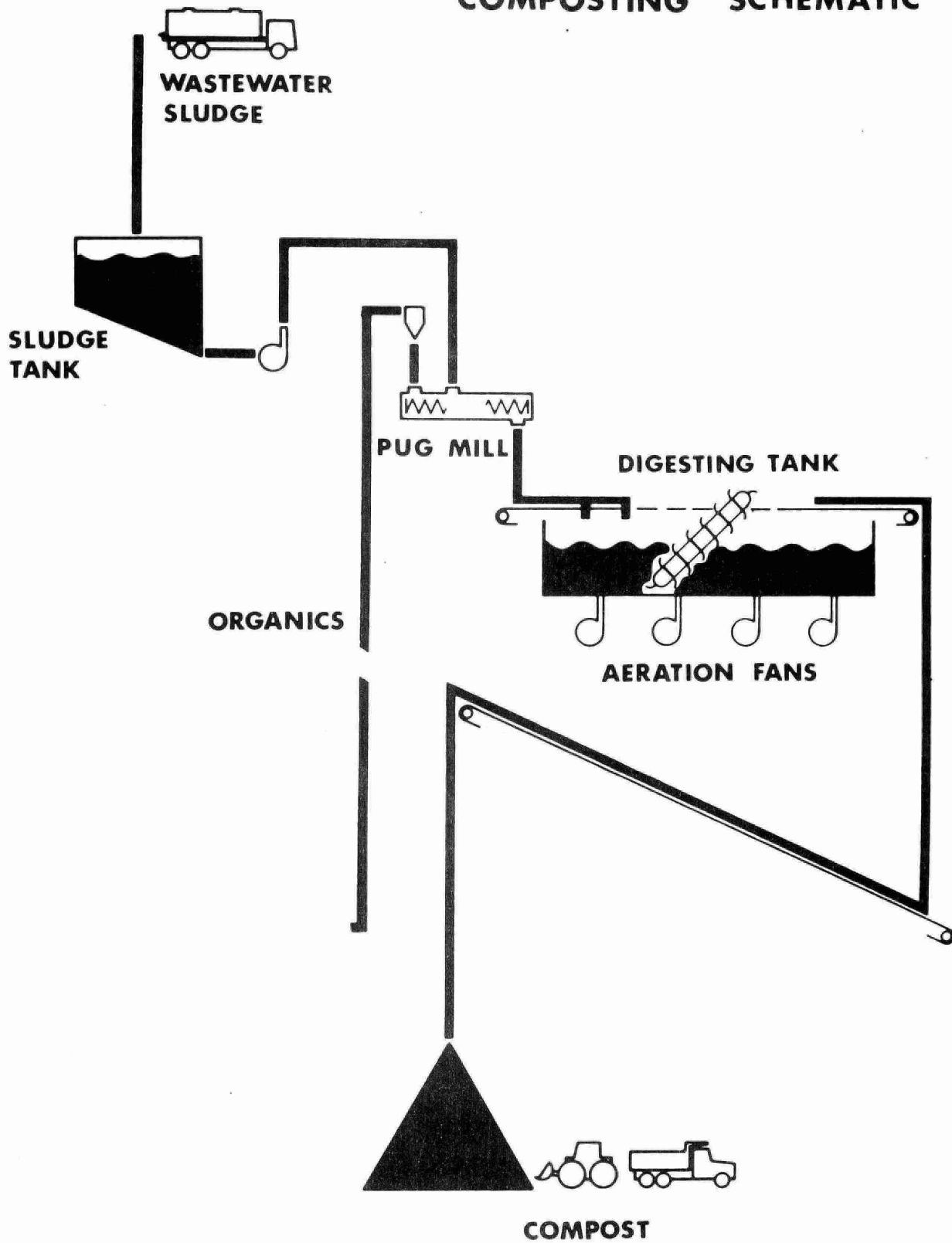


FIGURE 8

18

COMPOSTING SCHEMATIC



the bottom of the digestion tank; temperature and oxygen sensors within the digester control and blower output. Finished compost is then discharged onto an adjacent concrete pad where the produce is stored for shipping.

ADDITIONAL FEATURES

While the individual unit operations mentioned previously may be found in service at various solid waste processing plants on the continent, a unique feature of this facility is the combination of many elements of resource recovery into a full scale processing plant that also serves as a research and development centre.

However, the Experimental Plant also features more than numerous unit operations.

Perhaps one of the greatest problems in handling and processing solid waste is the generation of large quantities of dust; which if not controlled, obviously produces an uninviting and possibly hazardous working environment. In the Experimental Plant, an extensive dust control system has been provided; all major points of dust generation, e.g. material transfer locations, are enclosed and kept under negative pressure. Baghouses are used for dust removal from these pickup points and from the pneumatic conveying systems; dust is then conveyed either to the compactors, or product storage bins for disposal or utilization.

In addition, extensive use has been made of enclosures, skirting, and return belt scrapers and brushes on conveyors to prevent spillage.

While common in industry, the Experimental Plant has several features not commonly found in municipal works facilities. Among these are an extensive instrumentation system, closed circuit television monitoring, and the use of a computer for handling process data, production information, power consumption in key areas, as well as all truck scale information.

MARKETING

The marketing efforts of the Ministry involve the identification of existing and potential markets, assessment of the present supply and demand forces and marketing structure for each commodity, development of these markets through education and demonstration projects, and ultimately obtaining commitments for the use of recovered resources. It is in the latter commitment

stage that such aspects as product specifications, pricing mechanism, delivery schedules, tonnage levels, and risk allocation are considered.

The main thrust of market development activities to date has been on products expected to be produced at a conventional "front-end" processing facility, including waste newspapers, corrugating materials, municipal ferrous scrap, and an air classified light fraction. Successful market development for these materials obviously has general applicability throughout the province and confirmation of such markets is an essential prerequisite when a municipality is considering construction of a resource recovery plant.

ENERGY

As discussed earlier, solid waste represents a significant source of energy, with the light fraction having approximately half the calorific value of coal. Because of its suitability as a fuel, this light fraction is frequently referred to as "refuse derived fuel" or RDF.

In the market development of this material as an energy source, the Ministry of the Environment is undertaking two major demonstration projects.

One is the "Watts from Waste" project, a study of the applicability of suspension burning of RDF as a supplementary fuel in one of Ontario Hydro's existing thermal/electric generating stations. This joint project, involving Ontario Hydro, the Ministry of the Environment, and Metropolitan Toronto, consists of construction of a solid waste processing plant to provide 500 tons per day of RDF to allow 10,000 hours of firing at the Lakeview Generating Station. The design of facilities and equipment is in progress with a projected start-up date of late 1979.

The other major demonstration project involving the use of refuse derived fuel (RDF) is being undertaken by the Ministry of the Environment and Canada Lafarge Limited at the company's Woodstock plant. The project involves the use of RDF as a supplementary fuel during the period when coal is used as a primary fuel.

As the production of cement is highly energy intensive, and with cement plants generally located near major population centres, the industry as a whole has excellent potential for the use of RDF as an energy source.

Another promising area for the use of the light fraction is in the dewatering of sewage sludge to improve the calorific value of the dewatered sludge allowing autogenous combustion during incineration. Recent full scale studies have indicated that primary fuel reductions of up to 40 percent can be attained by substituting waste paper for conventional conditioning chemicals used in the dewatering of sewage sludge by vacuum coil filters. These energy savings are primarily due to the waste paper increasing the calorific content of the dewatered sludge. Additional dewatering by means of a cone press allows an autogenous incinerating sludge to be achieved.

FERROUS METALS

The major market development areas for the use of municipal ferrous scrap are the iron and steel foundries, and the de-tinning industry. The approximately 0.3 percent tin present in municipal ferrous scrap acts as a significant hindrance to the use of this material in the basic steel industry. Although dilution of the municipal scrap charge can be used to overcome this hindrance, it is generally felt that considerably more quality control would be required to ensure satisfactory steel production.

Trial melts using municipal ferrous scrap have already been conducted in several gray iron foundries and at a steel mini-mill. Test results have been satisfactory to the extent that purchase contracts for this material from the Experimental Plant for Resource Recovery have been placed with the Ministry.

When a new commodity supply is introduced to the secondary materials market, the question of end effect must be considered. If the new material merely displaces other scrap materials presently being recycled, then little net improvement in resource recovery is attained. In the case of ferrous scrap recycling, Canada now imports over 600,000 tons of scrap annually and present projections call for an imminent shortage of some 1,000,000 tons of scrap per year. Recycled municipal ferrous scrap would help fill this gap in scrap requirements.

WASTE PAPER

When considering markets for the various commodities presently recycled, the market for waste paper is generally considered to be the most volatile. In addition to the relatively unstable pricing for waste

paper, the overall market is characterized by a strong, steady demand for premium grades, in short supply, and a weak unstable demand for bulk grades, either in excess supply or very readily generated to produce excess supply. Consequently, the efforts of the Ministry of the Environment are aimed at increasing the supply of premium grades, e.g. through office separation studies, and at increasing the demand for bulk grades through expanding existing markets and developing new uses for these materials. Some of the development areas for waste paper usage are: as a raw material in the production of cellulose fibre insulation; as an agricultural bedding substitute; and as an energy source. These areas are being developed in conjunction with the traditional markets for waste paper, the building material industry, and the boxboard and related paper products industry.

OTHER COMMODITIES

While the Experimental Plant for Resource Recovery will be producing additional materials such as a mixed glass fraction, compost, and a non-ferrous metals fraction, intensive market development efforts for these products must await production of the materials themselves. With production, material characteristics will be defined and potential uses and users may be developed.

RESEARCH AND DEVELOPMENT PROGRAMS

Priority will be given to those sections of the plant with the potential for immediate economic application in other areas. This comprises the receiving, transfer, and direct paper recovery facilities, the shredding, air classification, and magnetic separation processes, and the storage and handling of the classified light fraction.

Investigations will be directed to:-

1. Development of accurate capital, operating and maintenance cost data for each unit operation.
2. Improvements to the efficiency of operation.
3. Possible environmental problems and particularly dust control requirements.

FIGURE 9

RESEARCH DEVELOPMENT PRIORITIES

1. RECEIVING, TRANSFER AND DIRECT PAPER RECOVERY.
2. SHREDDING, AIR CLASSIFICATION AND MAGNETIC SEPARATION.
3. STORAGE AND HANDLING OF LIGHT FRACTION.

4. The preparation of design criteria for future plants.
5. Operator training procedures.

We will also be investigating the possible use of plant facilities in combination with source separation projects; means of accelerating market development activities in the waste paper and ferrous metal fields; and on the development of alternative uses, rather than as a fuel, for the classified light fraction.

Subsequently, we will be carrying out similar programs for the composting, energy recovery and glass recovery processes.

One of the terms of reference for the plant design was that it should be capable of accommodating, without major structural or process modifications, the addition of other process modules from time to time.

We anticipate that these modules could be added to the basic plant by government, by private industry, or by both jointly.

Some obvious areas for assessment are:-

1. Separation of plastic film from classified light fraction.
2. A pyrolysis module producing a low temperature gas from the organic fraction.
3. Non-ferrous metal recovery.
4. Glass-rich fraction upgrading.

At this stage, only very general criteria for selection and assessment of priorities can be given. These would include:-

1. Stage of development of process.
2. Range of application in Ontario
3. Markets for recovered product.
4. Possible effects on landfill requirements.

FIGURE 10

AREAS OF INVESTIGATION

1. CAPITAL, OPERATING AND MAINTENANCE
COST DATA.
2. IMPROVED EFFICIENCY.
3. ENVIRONMENTAL AND DUST CONTROL
PROBLEMS.
4. DESIGN CRITERIA.
5. OPERATOR TRAINING PROCEDURES.

5. Potential for further development.
6. Cost - capital, operating and maintenance; income; and environmental effects.

To recapitulate the advantages provided by staged plant development, based on a modular approach as in the Experimental Plant, we believe it offers:-

1. Adaptability, to local conditions and local markets.
 2. Flexibility, to incorporate new technology and exploit new markets.
 3. Flexibility, to optimise plant location in relation to both centroid of waste production and available markets.
 4. Minimum total system cost, both capital and operating.
 5. Minimal risk.
- and
6. In the long run, maximum recovery and minimal dependence on landfill.

We also recognise that there will be exceptions where local conditions may make the selection of one of the alternative technologies available more appropriate. The staged development discussed has obvious advantages, but it has one major constraint; in some areas, it may not be applicable immediately, and even where applicable, it will not minimise landfill immediately.

However, we remain firmly convinced that an Ontario-wide program can be implemented most rapidly, at least cost, by the approach I have described.



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